

## Developing, Maintaining, and Restoring Team Cohesion

Completed Technology Project (2009 - 2013)



## Project Introduction

Team cohesion, as an important team process factor, has been researched in the psychological literature for well over 50 years. Several meta-analytic investigations have firmly established its contribution to team effectiveness (Beal, Cohen, Burke, & McLendon, 2003; Gully, Devine, & Whitney, 1995; Mullen & Copper, 1994), particularly for teams performing complex, interdependent tasks. Team cohesion is primarily viewed as a motivational team process that captures the interpersonal attraction of team members to each other (social cohesion) and the commitment of members to the team mission (task cohesion). Although task cohesion is more strongly related to team performance, both factors are important because problems with social cohesion can “spill over” to undermine task cohesion, other relevant team processes, and team performance (Kozlowski & Ilgen, 2006). Thus, the capability to intervene to enhance the development, maintenance, and restoration of team cohesion for flight crews and ground control teams is essential to the overall mission effectiveness for the NASA strategic plan for space exploration (NASA, 2008).

Team cohesion, good collaboration, and psychosocial health are essential ingredients for effective “high reliability” action teams that perform critical tasks in isolated, confined, and extreme (ICE) environments, such as teams of astronauts. Although a substantial amount of research has established a relationship between team cohesion and team effectiveness, very little research examines how teams collaborate and maintain cohesion, effective teamwork, and psychosocial health over time. That is, the vast majority of the research is based on static, cross-sectional data. There is simply very little research examining team cohesion and team functioning over short, medium, and long duration missions. Thus, basic research to examine team interaction dynamics is needed to develop effective and obtrusive assessment methods, monitoring technologies, and team regulation tools and techniques to enable crew members and mission controllers to maintain, sustain, and adapt team collaboration to achieve team effectiveness. That is the focus of this research effort.

This ground-based research focused on three primary areas of activity:

1. We worked to gain access to NASA analog environments with the goal of benchmarking team cohesion variability and fluctuations for teams operating under ICE conditions.
  - Establishing normative benchmarks for team interaction and function is critical to (later) being able to detect anomalies that necessitate countermeasures.
2. We developed and prototyped a technology platform (i.e., a wireless sensor system) to provide an unobtrusive measurement system for monitoring team interactions and assessing psychosocial health.



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- Real time cohesion and collaboration assessment will be critical to monitoring team effectiveness and triggering countermeasures.

3. We prototyped the use of behavioral metrics to assess team cohesion, which is a critical first step for establishing the utility of the monitoring technology, and initiated a phased validation process to demonstrate the potential of the monitoring technology and measurement system.

- It is essential that the technology system provides reliable, valid, and useful metrics for assessing the nature and quality of team interactions.

### Anticipated Benefits

Team cohesion is not just a critical factor for astronaut teams and ground crews; cohesion is important to the effectiveness of all teams and especially those that operate in critical, high reliability setting. Of the many team process factors that support team effectiveness, team cohesion is the most studied with over a half century of research. Yet, remarkably, very little is known about the characteristics that promote its development and maintenance. For example, we know that experience working together is associated with cohesion formation and maintenance, but what are the mechanisms? Teams that do not cohere replace problematic members or disintegrate so experience only reveals those teams that survive, but that does not tell us why or how. This research, which will uncover the dynamics of collaboration, cohesion, and effective team functioning and will create technologies to monitor team cohesion and guide interventions to restore it, has the potential for wide utility in aviation, military, medical, industrial, and other environments where society depends on the effective performance of high reliability teams.

### Organizational Responsibility

**Responsible Mission Directorate:**

Space Operations Mission Directorate (SOMD)

**Lead Center / Facility:**

Johnson Space Center (JSC)

**Responsible Program:**

Human Spaceflight Capabilities

### Project Management

**Program Director:**

David K Baumann

**Project Manager:**

Lauren B Leveton

**Principal Investigator:**

Steve Kozlowski

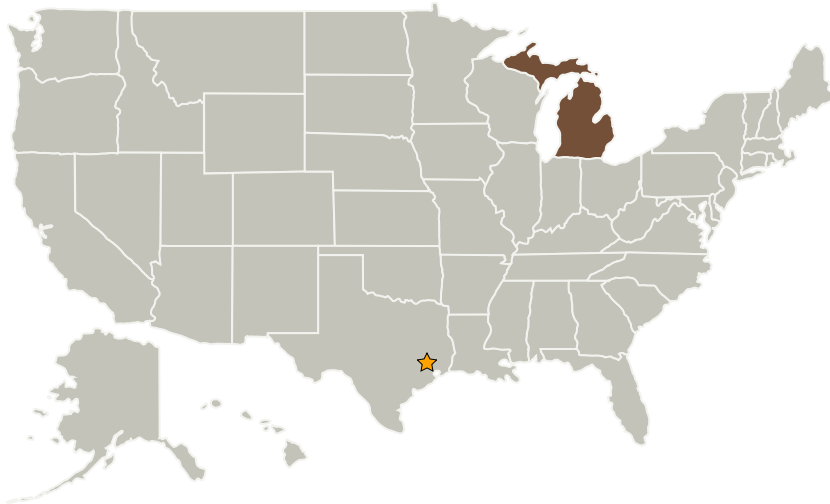
**Co-Investigators:**

Subir Biswas

Chu-hsiang (daisy) Chang



## Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
★ Johnson Space Center(JSC)	Lead Organization	NASA Center	Houston, Texas
Michigan State University	Supporting Organization	Academia	East Lansing, Michigan

## Primary U.S. Work Locations

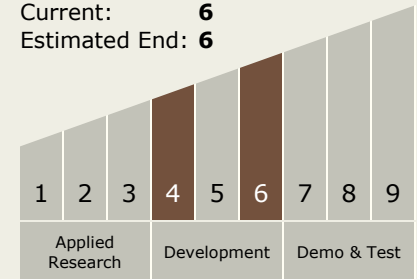
Michigan

## Project Transitions

 **August 2009:** Project Start

## Technology Maturity (TRL)

Start: 4  
Current: 6  
Estimated End: 6



## Technology Areas

## Primary:

- TX06 Human Health, Life Support, and Habitation Systems
  - TX06.3 Human Health and Performance
    - TX06.3.3 Behavioral Health and Performance

## Target Destinations

The Moon, Mars

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✓ **August 2013:** Closed out

**Closeout Summary:** Research Foci, Findings, and Conclusions Research Foci 1. NASA Analogs Longitudinal Data Collection s: The primary focus of the analog data collection was to cultivate access to analog teams (i.e., teams operating in isolated, confined, and extreme environment for long duration) to conduct benchmarking research to examine dynamic relationships between individual differences, team collaboration, cohesion, and conflict, and team effectiveness. 2. Technology Development and Prototyping: The primary focus of the monitoring technology research stream was to develop hardware and software to enable wireless, unobtrusive monitoring of team member collaboration and interaction during team task performance. 3. Validation of the Sensor Technology and Metrics: The primary focus of the validation research stream was to first demonstrate the value of behavioral metrics as a means to assess team cohesion and collaboration. This step allowed us to establish the potential of the behavioral monitoring technology as an assessment platform. Subsequent work used team simulation as a research platform to establish the reliability, validity, and utility of the monitoring technology (i.e., wearable badge) as a team interaction measurement system. NASA Analogs Longitudinal Data Collections Overview. The goal of the NASA analog data collection effort is to benchmark team functioning in long duration missions conducted in isolated, confined, and extreme (ICE) environments. As noted at the beginning of this report, there is a substantial amount of research examining the relationship between team cohesion and effectiveness, but the vast majority of the research is based on static data (i.e., cross-sectional research designs). Although such data are useful, they do not allow inferences regarding the dynamics of team cohesion and team effectiveness. Thus, as part of our effort to develop protocols for effective team functioning, it is necessary to establish benchmarks regarding team cohesion fluctuations (i.e., variation in mean levels, degree of member consensus), potential cohesion cycles, and the susceptibility of cohesion to shocks due to events internal and external to the team. Such data are necessary for the development of protocols to determine whether a team is functioning within normative parameters or is exhibiting anomalous patterns indicating the need for countermeasure activation. As noted in progress reports, the initial effort -- spearheaded by a subset of the original research team (Hough, Schmitt, & Locke) -- to gain access to scientific teams operating in a NASA analog environments were met with challenges. That initial effort was ultimately unsuccessful. Antarctic Science Search Teams. Responsibility for developing this line of analog was shifted back to the primary research team under the direction of the Principal Investigator. Through subsequent efforts to explore potential analog sites and facilitation provided by our NASA element scientist, we gained access to scientific teams who operated in Antarctica during the summer to search, collect, and catalog samples. Starting with the 2010 season, we have been collecting data every season through this analog site. The general study design is that prior to deployment, the scientific team members complete a pre-expedition survey that included items assessing their background and individual differences traits (e.g., personality). During the six-week mission, members complete daily diary surveys that asked them to reflect on their feelings and thoughts with regard to their team and personal experiences. Finally, members complete a post-expedition survey to evaluate their overall experience after they returned from the mission. The 2010-2011 season of data collection included two teams that covered different areas for searching and collecting samples. The blue team consisted of 4 members and the red team consisted of 4 members. Cohesion varied considerably over the duration of the mission for both teams. In addition, there were substantial differences in cohesion variability across the two teams. Moreover, there was considerably more change in cohesion over time in the red team versus the blue team. Specifically, while the blue team's cohesion stayed relatively consistent, the systematic team's cohesion was more volatile throughout the duration of the six-week mission. We coded specific incidents that may be triggers of cohesion variability for the two teams based on team members' open-ended responses on their daily diary. Overall, positive triggers like engaging in fun activities together and being productive as a team; and negative triggers like stress / fatigue, bad weather conditions, and uneven distribution of work among team members may be key factors influencing team cohesion over time. Those factors were associated with peaks and valleys of team cohesion. We were fortunate to have the opportunity to collect another round of data from this source in 2011-2012. Another team of scientists participated in a 48-day mission camped on the ice in Antarctica. We gathered similar data as we did last year in an effort to extend our benchmarking results. That is, using pre-expedition and post-expedition surveys, as well as daily diaries for team members and leaders, we assessed a number of key variables including: Individual differences (i.e., demographics and educational experience), daily thoughts and reactions regarding taskwork and teamwork, and member satisfaction and performance. As in the previous data collection effort, we used qualitative and quantitative measures in order to gain the most detail possible. Consistent with our findings in 2010-2011, this team's cohesion also varied substantially over time. While cohesion ratings tended to be favorable overall, the pattern became more stable toward the latter half of the season. In addition, members tended to disagree about how cohesive the team was nearer the beginning of the mission, whereas toward the middle of the mission, they started consistently converging that the team was cohesive. In order to examine the underlying causes of this pattern of cohesion, we read through team members' open-ended diary responses to identify its potential influencers. One important influencer of cohesion, particularly during the first half of the mission, was the boredom



## Stories

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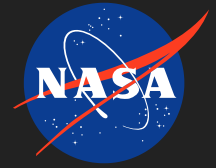
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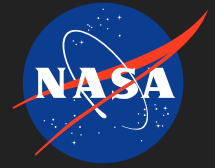
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### Project Website:

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